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The Influence of Location, Ownership and the Presence of a Co-Actor on the Processing of Objects

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Abstract

Humans operate in complex environments where social interactions require individuals to constantly attend to people and objects around them. Despite the complexity of these interactions from a visuomotor perspective, humans can engage and thrive in social settings. The purpose of the current study was to examine the simultaneous influence of multiple social cues (i.e., ownership and the presence of a co-actor) on the processing of objects. Participants performed an object-based compatibility task in the presence and absence of a co-acting confederate. Participants indicated whether pictures of mugs (that were either self-owned or un-owned) were upright or inverted. The pictures appeared at one of two locations (a 'near' or 'far' location relative to the participant) on a computer screen laid flat on (parallel to) the tabletop. When present, the co-actor stood on the opposite side of the screen/table. Analysis of response times (RTs) indicated that the processing of objects was influenced by the object's ownership status, the presence of the co-actor, and where the object was located on the screen. Specifically, RTs for pictures of self-owned mugs were shorter than un-owned mugs, but only when the pictures were located at the 'near' location. Further, the presence of a confederate resulted in shorter RTs for pictures located at the 'near', but not the 'far' location. These findings suggest that when objects were placed at the 'far' location, the additional social cues of ownership and social context did not influence visuomotor processing of the objects.

Keywords: Ownership, Peri-Personal Space, Action Space, Social Cognition, Visuomotor System

Public Significance Statement: The present experiment was designed to determine if the ownership status of an object and the social context of a situation (i.e., in the presence or absence of a co-actor) influenced the processing of objects placed ‘near’ to or ‘far’ away from an individual (i.e., at different distances from the body in peri-personal space). The results revealed that the social cues of ownership and the presence of another individual exert independent influences upon the coding of objects, and that their influence upon the processing of objects is modulated by the location of the object in space. These data provide new insight into the processes through which humans understand, interpret, and respond to the various social cues present in everyday human-object interactions.

Introduction

Everyday visuomotor interactions occur in dynamic environments and may be simultaneously influenced by a variety of social cues. The influence of these cues on how an object is processed within an environment might interact and change depending on the presence or absence of other factors, such as the location and intentions of other actors, and the ownership status of objects (see Borghi [2018] for a review). For example, when sitting alone at a coffee shop and working on a paper, you might move your cell phone to the far side of the table to avoid interacting with it and to focus on your work. However, if a friend joins you at the table and sits at that far side, your awareness of your phone being on the far side of the table and your sense of "ownership" or awareness of the phone may increase, even if the person is unlikely to interact with your phone. The purpose of the current paper was to examine if multiple factors that are present in everyday human-object interactions influence the manner in which an individual processes those objects. Specifically, the experiment was designed to assess how the ownership status of an object and the social context of a situation (i.e., in the presence or absence of a co-actor) influence the processing of objects placed 'near' to or 'far' away from an individual (i.e., at different locations in space).

Actionable Space and the Presence of Co-Actors

Evaluating how the human visuomotor system responds to objects placed in peri- and extra-personal space has provided valuable insight into the cognitive mechanisms that support object-based processing. Peri-personal space refers to reachable space for a given individual (i.e., within an arms-length of distance), while extra-personal space refers to unreachable space (i.e., beyond an arms-length of distance) (Griffiths & Tipper, 2012; Linkenauger et al., 2009; Rizzolatti et al., 1997). Studies have shown that the processing of objects in peri- and extra-personal space can change depending on different factors, including the presence of another individual (see Borghi, 2018; Saccone et al., 2018). For example, Costantini et al. (2011) examined how the presence of another individual influenced participants' "action-oriented object perception" by using a spatial alignment effect paradigm. Participants were presented with a series of images on a computer monitor. First, they viewed an instructional stimulus that depicted a left or right hand pantomiming a reach-to-grasp movement (see also Costantini et al. [2010] for similar methods and results). This reaching stimulus was followed by an image of a 3D virtual environment that included a mug located at one of two locations on a table (i.e., either within or beyond the participants' peri-personal space). The mug's handle was oriented towards either the left or the right. Once the participants saw the mug (the 'go' signal), they were required to replicate the grasp that they had previously observed in the instructional stimulus. Compatible trials were trials in which the handle of the mug was on the same side of space as the hand that was required to pantomime the previously observed grasp. Incompatible trials were those in which the grasping hand was on the opposite side of space from the mug handle. When the participants acted alone under these conditions, a compatibility effect (i.e., shorter response times [RTs] on compatible than incompatible trials) emerged when the picture of the mug was located within the participants' peri-personal space, but not when the object was located within their extra-personal space.

Of key theoretical importance in the Costantini et al. (2011) paper was the comparison between object processing and RTs when the participant acted alone (as described in the previous paragraph) and when the participant acted in the presence of an avatar that was seated alongside the table in the 3D virtual environment. The avatar in this study was passive and never responded to the target. Recall that when the participant acted alone and avatar was absent, a compatibility effect (i.e., shorter RTs on compatible than incompatible trials) emerged when the picture of the mug was located within the participants' peri-personal space, but not when the object was located within their extra-personal space. Interestingly, when the avatar was present, a compatibility effect emerged regardless of the mug's location. The important feature in this social condition was that the mug in the participants' extra-personal space was now within the peri-personal space of the avatar. Costantini et al. (2011) suggested that when the avatar was present, the participants coded for both their own and the avatar's perception of space and that, as a result, the avatar's perception of space was incorporated as one's own perception of space.

In a second experiment, Costantini et al. (2011) manipulated whether or not the avatar could potentially 'act' upon the mug stimulus. On half of the trials, the mug was placed in front of a virtual clear glass panel such that the avatar could have acted on the mug. On the other half of the trials, the mug was placed behind the clear glass panel such that the avatar would be prevented from acting on the mug. Interestingly, the compatibility effect was present when the mug was in front of the glass but disappeared when the object was located behind the clear glass panel. These findings suggest that the avatar's potential for acting on the mug influenced the participants' processing of the object. When the avatar could not 'act' upon the mug, the participants' motor systems were not 'primed' with the various actions that could be executed upon the object (Costantini et al., 2011). Therefore, the presence of another individual and the action capabilities of that person influenced the manner in which observers processed the objects.

In particular, the data suggest that the processing of objects is influenced not only by the individual's own ability to interact with the object, but also by a co-actor's perception of space and ability to act on the object (Costantini et al., 2010, 2011). Indeed, areas of the cortex activated during the processing of objects and the actionability of those objects overlap and/or interact with the areas thought to be involved in the action observation (aka mirror neuron) system (for a review, see Sakreida et al., 2016). In sum, the results of several studies suggest that objects are processed differently by actors when the actor is responding alone or is in the presence of another potential co-actor.

Ownership in Actionable Space

In another independent line of research, the "ownership" status of an object has been shown to affect the way the visuomotor system processes objects. Ownership is an important higher-order property of an object that has a top-down influence on object processing separate from the bottom-up aspect of physical salience. Ownership of objects is an important component of social interactions, and the knowledge of possession influences how individuals physically interact with objects in a given environment. For example, the ownership status of an object influences individuals' preference for the object (with a preference for 'self-owned' over 'other-owned' objects; see Beggan, 1992).

Ownership also affects the visuomotor processing and the manipulation of an object in space (Constable et al., 2011, 2014, 2016). For example, Constable et al. (2011) found that object-based compatibility effects (see Gibson, 1979; Tucker & Ellis, 1998) were influenced by the ownership status of the object that was presented. In the Constable et al. (2011) version of the object-based compatibility task, participants were presented with images of mugs and were asked to indicate the colour of the handle (e.g., press the right button if the mug handle was red, and the left button if the handle was green). Critically, the mug presented on a given trial varied in ownership status. The mug could be owned by the participant (self-owned), not owned by anyone (un-owned), owned by the experimenter (experimenter-owned), or owned by another participant (other-owned). Constable et al. (2011) reported that a compatibility effect emerged (i.e., shorter RTs on trials in which the mug handle was on the same side of space as the required button-press response than when the handle was on the opposite side of space from the required button-press response) in the self-owned, un-owned, and other-owned conditions. No compatibility effect was reported in the experimenter-owned mug condition. The authors interpreted this finding as indicative of an inhibitory action process elicited by the social conventions associated with interacting with other people's possessions. That is, there was no affordance compatibility effect for the experimenter-owned mug because of social conventions that hinder an individual from using another person's objects. Although the other-owned mugs belonged to fellow participants, their ownership status was not made explicit to the participants, unlike the ownership status of the experimenter-owned mug. These findings suggested that there was a distinction between how objects with different ownership statuses were represented in the visuomotor system.

The concept of ownership not only influences how an individual physically interacts with objects in a given environment, but ownership status also influences the top-down salience or prioritization of the objects. Evidence for the emergence of an individual's preference or prioritization for self-owned objects was observed through a temporal order judgment task

(Constable et al., 2019). Participants were presented with images of a self-owned mug and an experimenter-owned mug randomly on the left or right side of space. The different mugs were presented at different times – temporally separated apart by variable stimulus onset asynchronies (SOAs). The participants' objective was to determine which of the two mugs appeared on the screen first. The point of subjective simultaneity (PSS) was the time difference between the presentations of each stimulus when a difference was no longer detectable by the participant. In theory, at long SOAs, participants should be able to make accurate temporal order judgments (i.e., which of the two objects appeared first). However, as the SOAs decrease, the task becomes more difficult, and objects that are prioritized by the participants are perceived as appearing earlier than they really did. In this way, the participant might judge the prioritized object as being presented earlier than the non-prioritized object even if the objects are presented simultaneously or even if the prioritized object is actually presented slightly after the non-prioritized object. In this way, the PSS is an index of the relative priority of an object. Constable et al. (2019) found that the PSS shifted in favour of the self-owned mug. That is, the self-owned mugs tended to receive priority such that, at shorter SOAs, participants judged the self-owned mug as appearing first rather than the experimenter-owned mug, even when the experimenter-owned object appeared first. Constable et al. (2019) concluded that this pattern of effects was consistent with the judgement and decision-making bias for self-relevant stimuli.

Self-relevant information has also been shown to influence participants' movement times. In a study conducted by Desebrock et al. (2018), participants completed a perceptual matching task. The participants were presented with a shape-label stimulus and their task was to move from a home position and indicate via a button-press response whether or not the label (i.e., 'yours' or ‘theirs’) appropriately matched the shape (as determined by shape-label pairings at the beginning of the experiment). It was found that movement times were shorter for pictures of objects associated with “oneself” than for objects associated with another person. This movement time benefit for self-relevant objects was interpreted to stem from the well-established phenomenon of self-prioritization in cognitive processing (e.g., Sui et al., 2012; see also Scorolli et al., 2018). This effect holds when extended to ownership (Golubickis et al., 2018, 2019; Strachan et al., 2020).

In sum, the concept of ownership influences the processing of an object. That is, there is a preference for self-owned compared to other-owned objects (see Began, 1992) and ownership also appears to influence individuals’ visuomotor systems (Constable et al., 2011, 2014, 2019; Truong et al., 2016; Turk et al., 2011). In addition, self-relevant objects can influence the execution of motor responses (Desebrock et al., 2018). However, it is unknown how: a) ownership and b) the location of the owned object in space might interact in their effect on visuomotor processing. Specifically, do the processing benefits associated with self-owned objects vary depending on whether or not the object is located in peri- versus extra-personal space? For example, it could be that ownership is only relevant to individuals’ visuomotor systems when the object is in actionable peri-personal space, but it is not relevant in non-actionable extra-personal space. Such an effect would be revealed if self- and other-owned objects were processed differently in peri-personal space, but similarly in extra-personal space. Further, it is not clear if any influence of object ownership is modulated (heightened or lessened) by the presence of another individual. This change in object processing based on social context is particularly possible for an un-owned object or one whose ownership status is not clear (e.g., see Scorolli et al., 2018).

Overall, the present study aims to connect the insights provided by other research on social context and ownership to provide new insight into how these factors might shape the processing of actionable objects together. The findings of Costantini et al. (2011) and Saccone et al. (2018), who manipulated the presence of a co-actor in peri- and extra-personal space, will be extended by simultaneously examining the social cues of space, ownership and social context. Consequently, this study will help us understand how individuals process multiple social cues simultaneously, which in turn, enables us to function in the complex world we live in.

The Present Study

The purpose of the current experiment was to evaluate how the processing of an object is influenced by the following factors: spatial location (‘near’ or ‘far’ space relative to the participant), social context (presence or absence of a co-actor), and ownership (an image of a self-owned or un-owned object). To address this question, participants’ response times (RTs) to pictures of mugs that differed in ownership status were analyzed. These images were presented on a horizontally oriented computer monitor laid flat on a table. Participants sat at one edge of the monitor and the image could appear at one of two distances (i.e., ‘near’ or ‘far’) from them. Participants were required to indicate via a button-press response if a picture of a mug (with its handle oriented to the left or the right) was upright or inverted relative to where they were sitting. Consistent with Saccone et al. (2018), the task was performed in the absence and presence of a confederate who seemingly participated in the task on the other side of the computer monitor such that the ‘far’ location for the participant was the ‘near’ location for the confederate and the ‘near’ location for the participant was the ‘far’ location for the confederate. Although an object-based compatibility effect might be examined as a result of the hand required to execute the button-press response and the side of space in which the mug handle stimuli was oriented (i.e., to the left or right side of space), we situate our predictions within the self-prioritization literature and thus, analyze response times directly to evaluate how ownership may prime action within a given space (e.g. Strachan et al. [2020], but see the Discussion for a commentary on compatibility effects).

Based on previous work showing a processing advantage for self-owned objects (Golubickis et al., 2018, 2019), it was predicted that RTs to self-owned mugs would be shorter than RTs to un-owned mugs. However, it is unknown whether or not the processing advantage for self-owned objects is modulated by the location of the object in peri-personal versus extra-personal space (i.e., whether or not there is the potential for the individual to act on the object; see Costantini et al., 2010, 2011; for a review, see Borghi, 2018). Previous research has theorized that the ownership of space may implicitly signify the potential to act upon objects (Strachan et al., 2020). In this respect it was predicted that a self-owned facilitation effect in RTs would only be present for objects located at the ‘near’, but not the ‘far’ location because there is no immediate potential for action.

Further, it was predicted that the processing of objects would be influenced by the presence of another individual (Di Pellegrino & Làdavas, 2015; Saccone et al., 2018). Specifically, it was predicted that the co-actor’s ‘actionable’ space would be incorporated or adopted into the participants' 'actionable' space (in a manner similar to Costantini et al., 2011) when the task was performed in the presence of a co-actor (who stood on the other side of the horizontally oriented computer monitor). If the presence of another individual modulates the coding of space, then objects located at the 'far' location (i.e., closer to the co-actor) that were perceived to be beyond the participants' 'actionable' space in the alone condition would now be capable of being 'acted' upon. If so, then objects in far space would be processed as efficiently as those in near space when the co-actor is present.

Finally, the presence of the other individual and the inclusion of the co-actor's sensorimotor perspective into one's own perspective may, in turn, affect how the social cue of ownership is processed. If such an interaction occurs, then the influence of ownership might be heightened in far space when the co-actor is present. Specifically, it was hypothesized that in the presence of a co-actor, the ownership facilitation effect would emerge for objects located at both the 'near' and 'far' location due to the incorporation of the co-actor's sensorimotor perspective into one's own (Costantini et al., 2011). Alternatively, if ownership and the presence/absence of the co-actor independently influence object processing, then the ownership facilitation effect would not be affected by the presence/absence of the co-actor.

Methodology

Participants

Twenty-eight participants (23 females; *M* = 22.3 years, *SD* = 3.8 years) from the University of Toronto community completed the study. All participants reported normal or corrected-to-normal vision and all were right-hand dominant. Participants gave informed consent and the experiment was consistent with the ethics protocols that were approved by the Office of Research Ethics at the University of Toronto. The experiment took 60 minutes to complete and the participants were compensated ($10 CAD plus a mug) for their time. The present sample size was not justified by an *a priori* power analysis, but was based upon (and larger than) studies conducted in this area that employed similar methods (e.g., n = 19, Constable et al. [2011]; n = 15, Costantini et al. [2010]; n = 20, Costantini et al. [2011]).

Instruments and Apparatus

Photographs of four mugs that were identical in shape and size, but that varied in colour (blue, black, red or beige) served as stimuli. Each mug was photographed with the mug handle orientation perpendicular to the line of sight from the camera. The image of each mug was flipped on the vertical and horizontal axes to produce a total of 4 different mug orientations for each colour of mug (i.e., upright with the handle oriented to the right, upright with the handle oriented to the left, inverted with the handle oriented to the right, and inverted with the handle oriented to the left). The mug stimuli were approximately life-size when presented on the computer screen, with dimensions of 9.6 cm by 11.1 cm (actual mug size was approximately 11 cm by 13 cm).

All stimuli were presented on a computer monitor that lay flat on the table. The monitor was a 41 x 34 cm Dell LCD computer monitor (model 1908FP-BLK) with a resolution of 1280 x 1024 pixels, operating at 60 Hz. During the tasks, the stimuli were either placed at a ‘near’ or a ‘far’ location on the computer screen with respect to the participant. The center of the ‘near’ stimulus was ~6 cm from the edge of the screen closest to the participant (~23 cm relative to the participant) and the center of the ‘far’ stimuli was ~32 cm from the near edge of the screen closest to the participant (~49 cm relative to the participant). While arm lengths and reaching distances were not quantified, the mug located at the ‘near’ location could easily be ‘acted’ upon, whereas the stimuli located at the ‘far’ location could be ‘acted’ upon with a slight forward torso lean. These dimensions were in accordance to similar work conducted by Saccone et al. (2018) whose objects appeared between 15 and 45 cm away from the participants. The stimuli were centered horizontally on the screen with respect to the entire object (the mug handle and body inclusive; i.e., there was an equal amount of distance [11.45 cm] from the sides of the screen to the edge of the handle and the edge of the barrel). The centering of the stimuli with respect to the entire object, as opposed to the barrel of the mug, was chosen to potentially avoid the contamination of any potential spatial compatibility (Simon) effects associated with the large handle extending into one side of space (Cho & Proctor, 2010). A custom program written in E-prime (2.0) controlled the presentation of the stimuli and recorded the responses. Responses were executed on a standard QWERTY keyboard.

Procedure

Upon arrival to the experimental session, participants were required to pick one of three differently coloured mugs (either red, blue or black) to ‘use’ during the experiment and to keep afterwards (7 participants selected the red mug, 12 participants selected the blue mug, and 8 participants selected the black mug). The beige mug was always used as the control un-owned mug in the computer programs and so was not offered as an option to participants. Once the participant had chosen their particular mug, they were asked to carry the mug into the experimental chamber with them, and to store the mug along with one of their personal belongings (e.g., their backpacks). Participants carried and placed their mugs with their other belongings to enhance the sense of ownership over the mug. Importantly, the participant's mug was not within eyesight during the experimental procedure. To indirectly expose the participants to the control un-owned mug, the beige mug was placed inside an open basket in the experimental chamber.

Prior to the beginning of the experiment, the participants were informed that they would be completing the task twice, once alone and once while their partner (a confederate) completed the same task on the opposite side of the computer monitor (see Figure 1a and 1b). The order of conditions (joint first or alone first) was alternated for the tested participants. The participants who completed the joint condition first were informed that their partner had arrived earlier and had already completed the alone condition, and hence, the pair would complete the joint condition first. The participants who completed the alone condition first were told that their partner was late, but would arrive shortly, and hence, the participant would complete the alone condition first. Two confederates assisted the experimenter with data collection. Both confederates were young female adults who volunteered in the lab where data collection took place. Although the confederates had different physical characteristics, both confederates were the same age and interacted with the participants in a similar, neutral manner. The participants were naïve to the confederate's prior knowledge of the task.

Each trial began with a black central fixation cross (2 cm x 2 cm) that was presented in the middle of a white screen for 1000 ms (see Figure 1c). Two photographs of mugs with different ownership statuses were used as stimuli for each participant. One photograph was of the mug that belonged to the participant and the other photograph was of the beige control un-owned mug (the ownership status of the beige mug was never explicitly discussed with the participants). For each trial, one of the two mugs (either the self-owned or control mug) was presented either at a ‘near’ or ‘far’ location on the screen. Participants were asked to indicate whether the mug presented on the computer screen was upright or inverted by pressing the ‘z’ or ‘3’ button on the keyboard with their left or right hand, respectively. The same key was consistently used for ‘upright’ and the same key was consistently used for ‘inverted’ responses. The key/response association was not counterbalanced. It was stressed that the orientation of the mug handle was irrelevant to the task. Participants were instructed to respond as quickly and accurately as possible. The stimuli remained onscreen until a response was made or until 1500 ms had elapsed. Response times (RTs – onset of the stimulus until the keypress response) and accuracy were measured. A blank screen was presented for 2000 ms to finish the trial. Ownership status (participant-owned or control un-owned), spatial location (‘near’ to or ‘far’ away from the participant), and compatibility (mug handle on the same side [compatible trial] or on the opposite side [incompatible trial] from the required keypress response) were randomized across trials.

In the joint condition, a confederate sat on the opposite side of the table, and seemingly participated in the task simultaneously to the participant. The participant and confederate were instructed to indicate if the mug was upright or inverted based upon their own point of view. They were informed that once both of them executed a key-press response that the trial would end. However, the participant was unaware that the conclusion of each trial was solely dependent upon their key-press response, and not dependent upon the confederate’s response (in fact, the confederate’s keyboard was not connected to a computer, though the participant could not observe the unattached USB connection). The confederates were instructed to respond to the stimuli promptly so as to not cause suspicion from the participants (see Saccone et al., 2018).

Both the alone and joint conditions consisted of 4 blocks of 80 trials, for a total of 320 trials per condition and a total of 640 trials per experimental session. The 2 (ownership status) x 2 (space location) x 2 (compatibility) design led to 8 possible combinations. Each combination was presented 10 times per block, resulting in 80 trials per block. Stimulus presentation conditions were fully randomized (without replacement) within each block. Participants were required to take a ten-minute break between conditions. During the break, participants were asked to retrieve their mug from their belongings, and to wash the mug in the laboratory's kitchenette. The participants were permitted to relax during the remaining part of their break. The mandatory ten-minute break, and the cleaning of the mug was included in an attempt to re-establish/re-affirm ownership over the mug, and in an attempt to negate any potential practice, fatigue or boredom effects carrying over from the first experimental condition to the second experimental condition.

Results

An average of 6% of responses were removed from each participant's dataset due to incorrect responses or due to a lack of a response. RTs less than 100 ms (anticipatory responses) and RTs greater than 1000 ms (inattention errors) were removed. Once anticipatory and inattention errors were removed, RTs greater than two standard deviations above the mean (outliers - based upon a within-participant calculation) were removed from the dataset. On average, these outlier criteria led to approximately 5% of responses being removed per person. The data from one participant was removed from the dataset due to excessive errors (>25% errors). All of the remaining participants had error rates that were within two standard deviations above the mean. Henceforth, the final sample size was 27. Mean RTs were submitted to a 2 (Social Context: Alone or Joint) x 2 (Ownership Status: Un-owned Object or Self-Owned Object) x 2 (Space Location: Far or Near) x 2 (Compatibility: Incompatible or Compatible) repeated measures ANOVA. Tukey's *HSD* was used to conduct post-hoc analyses. Alpha was set at 0.05 for all analyses. It is important to note that Order (Alone condition first or Joint condition first) was included as a between-subjects variable in an initial ANOVA, but Order did not interact with any other factor and so Order was not included in the final analysis reported herein. Finally, note that the number of response errors participants committed was also analyzed using a separate ANOVA, but that this analysis of response errors did not reveal any statistically significant effects. Thus, although descriptive statistics for response errors are reported in Table 2, the analysis of errors is not reported below.

Analysis of mean RTs revealed a main effect of Space, F (1, 26) = 27.10, MS_e = 1696.06, $p<0.01$, $n_p^2 = 0.51$; RTs to stimuli presented at the 'far' location (M = 494 ms; SD = 13.92 ms) were longer than responses to stimuli presented at the 'near' location (M = 473 ms; SD = 13.00 ms). A main effect was also found for Ownership, F (1, 26) = 5.83, MS_e = 385.90, p = 0.02, n_p^2 = 0.18. Participants had longer RTs to un-owned mugs (M = 486 ms; SD = 13.13 ms) than to self-owned mugs (M = 481 ms; SD = 13.58 ms). Additionally, a main effect was found for Compatibility, F (1, 26) = 5.15, MS_e = 291.57, p = 0.03, n_p^2 = 0.17. This main effect revealed a very small, but statistically reliable "reverse" compatibility effect with RTs on incompatible trials being shorter (M = 482 ms; SD = 13.46 ms) than on compatible trials (M = 486 ms; SD = 13.23 ms). No main effect was found for Social Context, F (1, 26) = 0.05, MS_e = 14722.24, p =

0.83, $n_p^2 = 0.002$. Further, the factor of Compatibility did not interact with any other factor ($p>0.20$).

A significant interaction was found between Social Context and Space, F (1, 26) = 6.62, MS_e = 497.65, $p = 0.02$, $n_p^2 = 0.20$ (see Figure 2). For objects at the 'near' location, RTs to objects were shorter in the joint condition when the co-actor was present (M = 469 ms; SD = 13.03 ms) than in the alone condition when the co-actor was absent (M = 477 ms; SD = 15.06 ms; Cohen's d_z = 0.14). RTs for objects placed at the 'far' location were not statistically different in the presence (M = 496 ms; SD = 15.41 ms) and absence (M = 493 ms; SD = 15.25 ms) of another individual (Cohen's d_z = 0.04).

A significant interaction between Ownership and Space also emerged, F (1, 26) = 4.47, MS_e = 348.39, $p = 0.04$, $n_p^2 = 0.15$ (see Figure 3). RTs for un-owned mugs placed at the 'near' location (M = 478 ms; SD = 12.88 ms) were significantly longer than RTs to self-owned objects placed at the 'near' location (M = 469 ms; SD = 13.23 ms; Cohen's d_z = 0.65). There was no statistically significant difference in RTs for a self-owned (M = 494 ms; SD = 14.24 ms) or an un-owned mug (M = 494 ms, SD = 13.73 ms) placed at the 'far' location (Cohen's d_z = 0.05).

The three-way interaction of Social Context, Ownership, and Space, F (1, 26) = 0.03, MS_e = 177.19, $p = 0.87$, $n_p^2 = 0.001$, and the four-way interaction between Social Context, Ownership, Space, and Compatibility, F (1, 26) = 0.11, MS_e = 325.20, $p = 0.75$, $n_p^2 = 0.004$, were not statistically significant. Thus, although ownership and social context differentially influenced the processing of objects in near and far space, there was no evidence of an interactive influence of the factors of ownership and social context (see Table 1).

Table 1. Mean and standard deviation response time (ms) as a function of Condition, Ownership, Space and Compatibility.

Condition	Ownership	Space			
		Far		Near	
		Incompatible	Compatible	Incompatible	Compatible
Alone					
	Un-Owned Object	489 (14.6)	495 (15.3)	480 (14.9)	483 (15.0)
	Self-Owned Object	490 (15.9)	496 (16.4)	474 (16.3)	474 (15.2)
Joint					
	Un-Owned Object	498 (15.8)	495 (15.2)	473 (13.8)	475 (12.7)
	Self-Owned Object	490 (15.9)	499 (15.6)	461 (13.9)	468 (12.8)

Table 2. Mean and standard deviation of the number of errors as a function of Condition, Ownership, Space, and Compatibility.

Condition	Ownership	Space			
		Far		Near	
		Incompatible	Compatible	Incompatible	Compatible
Alone					
	Un-Owned Object	4.3 (0.46)	4.8 (0.44)	5.2 (0.64)	4.7 (0.41)
	Self-Owned Object	4.8 (0.43)	4.7 (0.40)	4.6 (0.36)	4.7 (0.47)
Joint					
	Un-Owned Object	4.1 (0.50)	4.5 (0.39)	3.9 (0.40)	4.5 (0.51)
	Self-Owned Object	4.8 (0.44)	4.3 (0.36)	3.8 (0.44)	4.6 (0.45)

Discussion

The purpose of the current experiment was to examine how ownership, space and social context modulated the processing of objects. Analysis of RTs revealed two important interactions. First, an ownership by space interaction was detected – an ownership facilitation effect was only observed for objects located within 'actionable' space (i.e., at the 'near' but not the 'far' location). Second, a significant interaction between social context and space was detected – the presence of a co-actor appeared to only influence the RTs to objects located at the 'near' but not the 'far' location. No other significant interactions were evident. The absence of a significant three-way interaction of ownership, space and social context suggests that the co-actor's perception of 'actionable' space was not incorporated or adopted into the participant's perception of 'actionable' space during the joint condition. In fact, the presence of a space by social context interaction actually suggests that the division of space became more salient in the presence of a co-actor. These findings suggest that the processing of objects was independently, but not interactively, influenced by ownership and social context. We will elaborate upon the significant effects in turn and discuss possible underlying mechanisms that may have led to these findings.

Compatibility Effects

Before addressing the main findings and contributions of the present study, the object-based compatibility effect will be discussed. An unexpected finding was that the main effect of compatibility revealed a "reverse" object affordance compatibility effect (cf., Cho & Proctor, 2010; Tucker & Ellis, 1998). Specifically, RTs for compatible trials (defined as the mug handle being on the same side of space as the required button-press response) were longer than RTs for incompatible trials (defined as the mug handle being on the opposite side of space as the required button-press response). The reverse compatibility effect reported here is in contrast to previous research reporting a compatibility effect where RTs were shorter when the functional component of the object (e.g., the mug's handle) was on the same side of space as the required button-press response (Constable et al., 2011; Saccone et al., 2018; Tucker & Ellis, 1998; but see Kostov & Janyan [2015] and Lien et al. [2014] for other demonstrations of “reverse” compatibility effects). There are several possible reasons why this very small (~4 ms) difference emerged in the present study; these possibilities will be discussed in the subsequent sections.

First, it is possible that the “reverse” compatibility effect may have been a result of a spatial compatibility effect (see Kornblum et al., 1990). Because the image of the mug was centered with respect to the body and handle of the mug inclusive, the majority of coloured pixels were located to the opposite side of the computer screen from the handle of the mug (see the Simon effect - Cho & Proctor, 2010). As such, participants may have oriented to and prioritized the side of the screen where the majority of the coloured pixels (i.e., the body of the mug) was located. Thus, the resulting orientation to the side of space with the bulk of the object may have led to a spatial compatibility effect associated with the object’s center of mass. Indeed, in a meta-analysis conducted by Azaad et al. (2019), the authors found that a number of features of the stimuli, including the way the stimuli were centered on the screen (i.e., the object’s centrality on the screen) influenced the strength of the compatibility effects observed. Specifically, objects that were object-centered (i.e., where the stimuli were centered with regards to the entire object – base and handle included) were found to lead to weaker compatibility effects than base-centered objects (i.e., where stimuli were centered with respect to the base of the object). In fact, the findings from the current experiment (which utilized object-centered stimuli) may support the conclusions put forth by Azaad et al. (2019) by suggesting that object-centered stimuli may lead to a spatial compatibility effect in the opposite direction to the protruding object handle.

A second possible explanation may be rooted in the nature of the stimulus presentation. Due to the horizontal positioning of the computer monitor, the orientation of the mug (as presented to the participants) was not presented in the upright manner that is typical for daily interactions and, indeed, in the majority of previous work (Cho & Proctor, 2010; Constable et al., 2011; Tucker & Ellis, 1998; but see Saccone et al., 2018). That is, the mug stimuli used in the current study were presented on a horizontally oriented computer monitor that was parallel to the table instead of on a typical vertically oriented computer monitor where the mug stimuli would be perpendicular to the table (see Figure 1c). This methodological design may have resulted in a conflict between the type of grasp that would typically be used to pick up a mug (i.e., grasping the mug handle with either the left or right hand) and the type of grasp that would be needed to lift a mug that is lying on its side (i.e., by grasping the body of the mug with one or both hands). The variation in the presentation orientation and associated action affordances in the current experimental design may have resulted in the absence of a typical compatibility effect, as the type of grasp that would be most appropriate to use may have been ambiguous to the participants.

In sum, it is unclear why the small but statistically significant “reverse” compatibility effect emerged. As previously mentioned, however, the presence or absence of a compatibility effect need not be the main indication for how the social cues of ownership, space and social context interact to influence object processing. Rather, here mean RTs will be used as an indication of how the various social cues shaped the way the objects were processed. As participants were instructed to respond as quickly and accurately as possible, how quickly the participants were able to process the stimuli will be representative of how salient each of the social cues (ownership, space and social context) were. The remainder of the Discussion will elaborate on how the remaining factors (ownership, space and social context) affected visuomotor processing.

Spatial Proximity

The main effect of space indicated that, overall, participants had shorter RTs to stimuli in ‘near’ space than ‘far’ space. One possible reason for this near/far space processing difference is that the objects located at the ‘far’ location were more difficult to recognize than the objects located at the ‘near’ location given the object’s relative distance from the participant and, perhaps, some factors associated with the use of an LCD monitor (such as differences in glare, brightness, or resolution due to differences in distance and viewing angle). This explanation seems unlikely because the objects located at the ‘far’ location were ~49 cm away from the participant (with similar measurements used by Saccone et al., 2018). Further, the objects were differentiated based on the fairly robust physical feature of colour that should be resilient to these small differences in distance and any potential presentation issue. Therefore, participants would likely have been able to identify the objects and complete the task efficiently.

A more likely possibility is that this effect is a consequence of differential processing as a function of visual field. Previc (1990) theorized that an individual’s lower visual fields are highly connected to the dorsal stream – the network of neurons that runs from the striate cortex and travels to the posterior parietal cortex. This network of neurons is theorized to specialize in integrating visual-motor information to aid in the execution of actions in peri-personal space (Goodale & Milner, 1992). Recall that the target objects were presented above and below a central fixation point, with ‘near’ objects in the lower visual field and ‘far’ objects in the upper visual field. Therefore, if the objects situated at the ‘near’ location were perceived through the lower visual field, the processing of these objects may have been facilitated because the participants viewed these objects to be within their ‘actionable’ space. On the other hand, an individual’s upper visual field is specialized for information that is located farther away from the individual, and thus, specialized for the perception of objects located within an individual’s extra-personal space. The upper visual field is more highly connected to the ventral stream, which transmits information from the striate cortex to the inferotemporal cortex, to aid in one’s perception of the identity, though not necessarily the actionability, of objects in the environment (i.e., an individual’s extra-personal space; Goodale & Milner, 1992; Previc, 1990).

In support of these distinctions, previous research has shown that visuomotor processing and the execution of goal-directed actions are more efficient when executed in the lower visual field than in the upper visual field (see Danckert & Goodale, 2001; cf., Binstead & Heath, 2005). Because the fixation cross was centrally located and closer to the individual than the image of the mug at the ‘far’ location, objects placed at the ‘far’ location may have been preferentially processed through an individual’s upper visual field. Given that the experimental task emphasized object orientation, not object identification, the nature of the task might have primed or have been better suited for lower (dorsal emphasized) than upper (ventral emphasized) visual field processing. Therefore, RTs to stimuli situated at the ‘far’ location may have been longer because these objects may have been perceived to be located beyond an individual’s ‘actionable’ space and not processed as easily as those objects perceived to be within ‘actionable’ space (Goodale & Milner, 1992; Previc, 1990). In contrast, research by Niebauer and Christman (1998) found that the upper visual field was specialized for categorical RT tasks, whereas the lower visual field was specialized for coordinate judgements. In the present research, participants were asked to determine whether the mug was upright or inverted: a categorical RT task. Based on the findings by Niebauer and Christman (1998), we would therefore expect to see a facilitation in RTs at the ‘far’ compared to the ‘near’ location, though such was not the case. Overall, the results indicate that the objects presented closer to the body were processed more readily than those farther from the body, and future research is encouraged to examine the relationship between visual fields and participants’ performance on RT tasks as a function of spatial proximity and the visual field in which it is presented.

Ownership in Actionable Space

The main effect of ownership revealed that participants had shorter RTs to images of self-owned mugs compared to un-owned mugs. This finding is consistent with numerous findings demonstrating the prioritization of self-relevant and owned objects (e.g. Constable et al., 2019; Desebrock et al., 2018; Golubickis, 2018, 2019; Truong et al., 2017), although it is also possible that the main effect of ownership may have emerged due to the differences between the stimuli themselves. Specifically, because self-owned mugs were relatively darker in colour (black, blue or red) compared to the lighter coloured un-owned mug (which was always beige), it is possible that the mugs’ physical characteristics resulted in differences in perceptual salience, thereby influencing RTs. However, attributing the main effect of ownership (i.e., slower RTs to un-owned compared to self-owned mugs) to the differences between the physical features of the stimuli themselves is likely an insufficient explanation for the findings from the current experiment. The presence of a space by ownership interaction suggests that objects located at the ‘far’ location were responded to in a similar manner regardless of ownership status/colour. In contrast, an ownership facilitation effect (i.e., faster response times to self-owned compared to un-owned mugs) emerged at the ‘near’ location. If the detection and/or processing of the un-owned mug was more difficult or less efficient for the participants due to its’ colour (i.e., a low-level perceptual feature), there should be no interaction between space and ownership (the ownership facilitation effect would emerge at both the ‘near’ and ‘far’ locations). Therefore, the ownership effect observed in the current experiment was likely the result of the social feature associated with ownership rather than the result of the mugs’ physical characteristics (i.e., low-level features) associated with the stimuli.

In fact, the finding of the interaction between ownership and space is consistent with other work that was simultaneously completed in another lab. Specifically, Strachan et al. (2020) found that the magnitude of the object-ownership effect varied based on the spatial location of the object. In a virtual sorting task, participants were asked to sort self-owned or other-owned objects (differentiated based upon shape) into either “self-” or “other-owned” baskets. The to-be-sorted objects could be initially presented over the consistent basket (e.g., self-owned object over the “self” basket) or over the inconsistent basket (e.g., other-owned object over the “self” basket). The authors observed a facilitation in RTs for self-owned relative to other-owned objects when the objects were presented over the “self” basket, but there was no difference in RTs for self- and other-owned objects when they were presented over the “other” basket. Recall that in the present work, RTs were shorter for self-owned objects compared to un-owned objects, but this facilitation effect only emerged when the objects were located in ‘near’ space close to the participant (similar to the self- versus other-owned facilitation effect over the “self” basket in the study conducted by Strachan et al., 2020). There was no significant difference in RTs between self-owned and un-owned objects when these objects were located at the ‘far’ location close to the confederate (similar to the null self- versus other-owned difference over the “other” basket in the study conducted by Strachan et al., 2020). Although there are many methodological differences between the two studies (most notably a co-actor was present in the current paper, but never present in the Strachan et al. study), the pair of studies provide converging evidence that the influence of object ownership has different influences depending on the spatial location of the object.

The novel finding in the present paper is that this influence of ownership is dependent on the spatial proximity of the object to the person. A possible explanation for the current findings is that motivational relevance plays a critical role in ownership-based effects (Constable et al., 2019). Here, the distinction between ‘near’ and ‘far’ space suggests that ‘near’ objects are perhaps more motivationally relevant due to their potential for action, whereas objects located at the ‘far’ location are less motivationally relevant since the objects cannot easily be ‘acted’ upon. Such an explanation is consistent with the assertion that relevance (Constable et al., 2019) and the location of objects play a large role in ownership effects (Scorolli et al., 2018; see Borghi [2018] for a review). In sum, there is converging evidence that the influence of object ownership appears to be modulated by the spatial location of the object.

Actionable Space and the Presence of Co-Actors

Although a main effect of social context was not observed, the interaction of social context and space illustrates that the presence of another individual affected the processing of the objects in the environment. Interestingly, RTs to stimuli presented in ‘far’ space (close to the co-actor) were not affected by the presence of the co-actor, whereas RTs to stimuli presented in ‘near’ space (close to the participant) were shorter when the co-actor was present than when the co-actor was absent. The absence of the main effect of social context suggests that the facilitation in 'near' space is unlikely to be solely driven by an arousal-based mechanism associated with the presence of a co-actor (e.g., Zajonc, 1965). Rather, the results suggest that space is segmented in the social condition between the participants' and the co-actors' own space. Stimuli in 'near' space may have been more salient to the participants' visuomotor systems, resulting in a boost to cognitive processing, with the additional benefit arising as the result of the distinction between 'self' and 'other' space becoming particularly salient when the co-actor was present.

There are two possible explanations for the discrepancy between the present findings and those of Costantini et al. (2011). First, it is possible that the actions carried out (or not) by the co-actor were influential upon the participants' coding of actionable space. In the present work, the co-actor completed the task simultaneously across the table from the participant, whereas the co-actor in the studies of Costantini et al. was a passive avatar that never interacted with the objects or within the environment. The passive co-actor in the study by Costantini et al. may have led the participants to engage in a perceptive taking process with the passive avatar. In contrast, the active co-actor used in the study by Saccone et al. (2018) (and in the current study) may have resulted in the participants' processing the task as a joint process (i.e., a more "we-mode" process) that resulted in the division of labour and contraction of space (see Constable et al. [2015] for an examination of active versus passive co-actors). Although passive versus active co-actors are a potentially relevant difference in methodology that may lead to differences in object processing, this issue is tangential to the current research goal and, as such, future studies should more directly explore whether the impact of an active versus passive co-actor is influential upon the coding of space (see also Bhatia et al., 2019).

The second potentially meaningful difference concerns the social context in which the tasks were performed. One particular feature of the instructions may have unintentionally led to negatively-valenced emotions towards the confederate: the cover story about the presence or absence of the confederate at the beginning of the experimental session. Recall that, to control for possible order effects, half of the participants completed the joint condition first and the other half completed the alone condition first. To explain the presence/absence of the confederate at the beginning of the experiment, half of the participants were told that their partner was running late, and therefore, the participant would complete the alone condition first, followed by the joint condition. The other half of the participants were told that their partner had arrived early and had already completed the alone condition, and therefore, the joint condition would be performed first. Miles et al. (2010) found that the tardiness of a confederate influenced how the participants subsequently performed in a behavioural synchrony task. Participants whose partner appeared on time for testing showed behavioural synchrony with their partner in the subsequent experimental task. Participants who had to wait 15 minutes for their partner to arrive did not show behavioural synchrony in a subsequent experimental task. Although this is a speculative explanation, it is possible that the instructions provided in the current study created some kind of resentment towards the confederate for being ‘late,’ and/or perhaps jealousy that the confederate was already half-way done their experimental session (see Miles et al., 2010). These negative emotions could have led to a retraction of space and thus prevented the participant from incorporating the co-actor’s peri-personal space into their own (as seen in Costantini et al., 2011; see also Borghi

[2018] for a review of related social context influences on tool and object processing). In sum, regardless of the exact mechanism, the presence of a co-actor appears to affect the way in which objects are processed in different spatial locations.

Summary

Overall, the findings of the present study add novel data to the cumulative body of literature demonstrating that contextual features, such as the presence of another person, the ownership-status of an object, and the location of an object in space, influence the way in which objects are processed (for a review, see Borghi, 2018). The findings demonstrate that ownership effects are sensitive to the location of the object in the environment; specifically, the self-prioritization effect in the current study only seems to occur when the object can potentially be 'acted' upon. The results also suggest that the presence of another individual is influential upon the processing of objects in space, however, the type of influence (i.e., a retraction or expansion in peri-personal space) is dependent upon the social context of the situation. Interestingly, the factors of ownership and the presence of a co-actor did not interact suggesting that these two factors have independent influences on the processing of space.

Open Practice Statement

The data and materials for the experiment reported here are available upon reasonable and justified request. The experiment was not preregistered.

References

Azaad, S., Laham, S. M., & Shields, P. (2019). A meta-analysis of the object-based compatibility effect. *Cognition, 190,* 105-107.

Beggan, J. K. (1992). On the social nature of nonsocial perception: The mere ownership effect. *Journal of Personality and Social Psychology, 62*(2), 229-237.

Bhatia, D., Spataro, P., Mishra, R. K., Cestari, V., Doricchi, F., & Rossi-Arnaud, C. (2019). Pointing movements and visuo-spatial working memory in a joint setting: The role of motor inhibition. *Psychological Research*. https://doi.org/10.1007/s00426-019-01209-y

Binstead, G., & Heath, M. (2005). No evidence of a lower visual field specialization for visuomotor control. *Experimental Brain Research, 162*(1), 89-94.

Borghi, A. M. (2018). Affordances, context and sociality. *Synthese,* 1-31. doi:10.1007/s11229-018-02044-1

Cho, D., & Proctor, R. W. (2010). The object-based Simon Effect: Grasping affordance or relative location of the graspable part? *Journal of Experimental Psychology: Human Perception and Performance, 36*(4), 853-861.

Constable, M. D., Bayliss, A. P., Tipper, S. P., Spaniol, A. P., Pratt, J., & Welsh, T. N. (2016). Ownership status influences the degree of joint facilitatory behavior. *Psychological Science, 27*(10), 1371-1378.

Constable, M. D., Kritikos, A., & Bayliss, A. P. (2011). Grasping the concept of personal property. *Cognition, 119*(3), 430-437.

Constable, M. D., Kritikos, A., Lipp, O. V., & Bayliss, A. P. (2014). Object ownership and action: The influence of social context and choice on the physical manipulation of personal property. *Experimental Brain Research*, *232*(12), 3749-3761.

Constable, M.D., Pratt, J., Gozli, D.G., & Welsh, T.N. (2015). Do you see what I see: Co-actor posture modulates visual processing in joint tasks. *Visual Cognition, 23*(6), 699-719.

Constable, M. D., Welsh, T. N., Huffman, G., & Pratt, J. (2019). I before U: Temporal order judgements reveal bias for self-owned objects. *Quarterly Journal of Experimental Psychology*, *72*(3), 589-598.

Costantini, M., Ambrosini, E., Tieri, G., Sinigaglia, C., & Committeri, G. (2010). Where does an object trigger an action? An investigation about affordances in space. *Experimental Brain Research*, *207*(1), 95-103.

Costantini, M., Committeri, G., & Sinigaglia, C. (2011). Ready both to your and to my hands: Mapping the action space of others. *PLOS ONE, 6*(4), 1-6.

Danckert, J., & Goodale, M. A. (2001). Superior performance for visually guided pointing in the lower visual field. *Experimental Brain Research, 137*, 303-308.

Desebrock, C., Sui, J., & Spence, C. (2018). Self-reference in action: Arm-movement responses are enhanced in perceptual matching. *Acta Psychologica, 190,* 258-266.

Di Pellegrino, G., & Làdavas, E. (2015). Peripersonal space in the brain. *Neuropsychologia, 66,* 126-133.

Gibson, J. J. (1979). *The ecological approach to visual perception.* Boston: Houghton-Mifflin.

Golubickis, M., Falben, J. K., Cunningham, W. A., & Macrae, C. N. (2018). Exploring the self-ownership effect: Separating stimulus and response biases. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *44*(2), 295–306.

Golubickis, M., Ho, N. S. P., Falbén, J. K., Schwertel, C. L., Maiuri, A., Dublas, D., Cunningham, W. A., & Macrae, C. N. (2019). Valence and ownership: Object desirability influences self-prioritization. *Psychological Research*. https://doi.org/10.1007/s00426-019-01235-w

Goodale, M. A., & Milner, A. D. (1992). Separate visual pathways for perception and action. *Trends in Neurosciences, 15*(1), 20-25.

Griffiths, D., & Tipper, S. P. (2012). Rapid communication. When far becomes near: Shared environments activate action simulation. *The Quarterly Journal of Experimental Psychology*, *65*(7), 1241-1249.

Kornblum, S., Hasbroucq, T., & Osman, A. (1990). Dimensional overlap: Cognitive basis for stimulus-response compatibility- A model and taxonomy. *Psychological Review, 97*(2), 253-270.

Kostov, K., & Janyan, A. (2015). Reversing the affordance effect: Negative stimulus-response compatibility observed with images of graspable objects. *Cognitive Processing, 161*, 287-291.

Lien, M.-C., Gray, D., Jardin, E., & Proctor, R. W. (2014). Further evidence that object-based correspondence effects are primarily modulated by object location not by grasping affordance. *Journal of Cognitive Psychology, 26*(6), 679-698.

Linkenauger, S. A., Witt, J. K., Stefanucci, J. K., Bakdash, J. Z., & Proffitt, D. R. (2009). The effects of handedness and reachability on perceived distance. *Journal of Experimental Psychology: Human Perception and Performance, 35*(6), 1649-1660.

Miles, L., Griffiths, J. L., Richardson, M. J., & Macrae, C. N. (2010). Too late to coordinate: Contextual influences on behavioral synchrony. *European Journal of Social Psychology*, *40*(1), 52-60.

Niebauer, C. L., & Christman, S. D. (1998). Upper and lower visual field differences in categorical and coordinate judgments. *Psychonomic Bulletin & Review, 5*(1), 147-151.

Previc, F. H. (1990). Functional specialization in the lower and upper visual fields in humans: Its ecological origins and neurophysiological implications. *Behavioral and Brain Sciences, 13*(3), 519-542.

Rizzolatti, G., Fadiga, L., Fogassi, L., & Gallese, V. (1997). The space around us. *Science, 277*(5323), 190-191.

Saccone, E. J., Szpak, A., Churches, O., & Nicholls, M. E. (2018). Close interpersonal proximity modulates visuomotor processing of object affordances in shared, social space. *Attention, Perception, & Psychophysics, 80*(1), 54-68.

Sakreida, K., Effnert, I., Thill, S., Menz, M. M., Jirak, D., Eickhofff, C. R., Ziemke, T., Eickhoff, S. B., Borghi, A. M., & Binkofski, F. (2016). Affordance processing in segregated parieto-frontal dorsal stream sub-pathways. *Neuroscience & Biobehavioral Reviews, 69*, 89-112.

Scorolli, C., Borghi, A. M., & Tummolini, L. (2018). Cues of control modulate the ascription of object ownership. *Psychological Research, 82*(5), 929–954.

Strachan, J. W. A., Constable, M. D., & Knoblich, G. (2020). It goes with the territory: Ownership across spatial boundaries. *Journal of Experimental Psychology: Human Perception and Performance*, No Pagination Specified-No Pagination Specified. https://doi.org/10.1037/xhp0000742

Sui, J., He, X., & Humphreys, G. W. (2012). Perceptual effects of social salience: Evidence from self-prioritization effects on perceptual matching. *Journal of Experimental Psychology: Human Perception and Performance, 38*(5), 1105-1117.

Truong, G., Chapman, C. S., Chisholm, J. D., Enns, J. T., & Handy, T. C. (2016). Mine in motion: How physical actions impact the psychological sense of object ownership. *Journal of Experimental Psychology: Human Perception and Performance, 42*(3), 375-385.

Truong, G., Roberts, K. H., & Todd, R. M. (2017). I saw mine first: A prior-entry effect for newly acquired ownership. *Journal of Experimental Psychology. Human Perception and Performance, 43*(1), 192–205.

Tucker, M., & Ellis, R. (1998). On the relations between seen objects and components of potential actions. *Journal of Experimental Psychology: Human Perception and Performance, 24*(3), 830-846.

Turk, D. J., van Bussel, K., Brebner, J. L., Toma, A. S., Krigolson, O., & Handy, T. C. (2011). When "It" becomes "Mine": Attentional biases triggered by object ownership. *Journal of Cognitive Neuroscience, 23(12)*, 3725-3733.

Zajonc, R. B. (1965). Social facilitation. *Science, 149*(3681), 269-274.

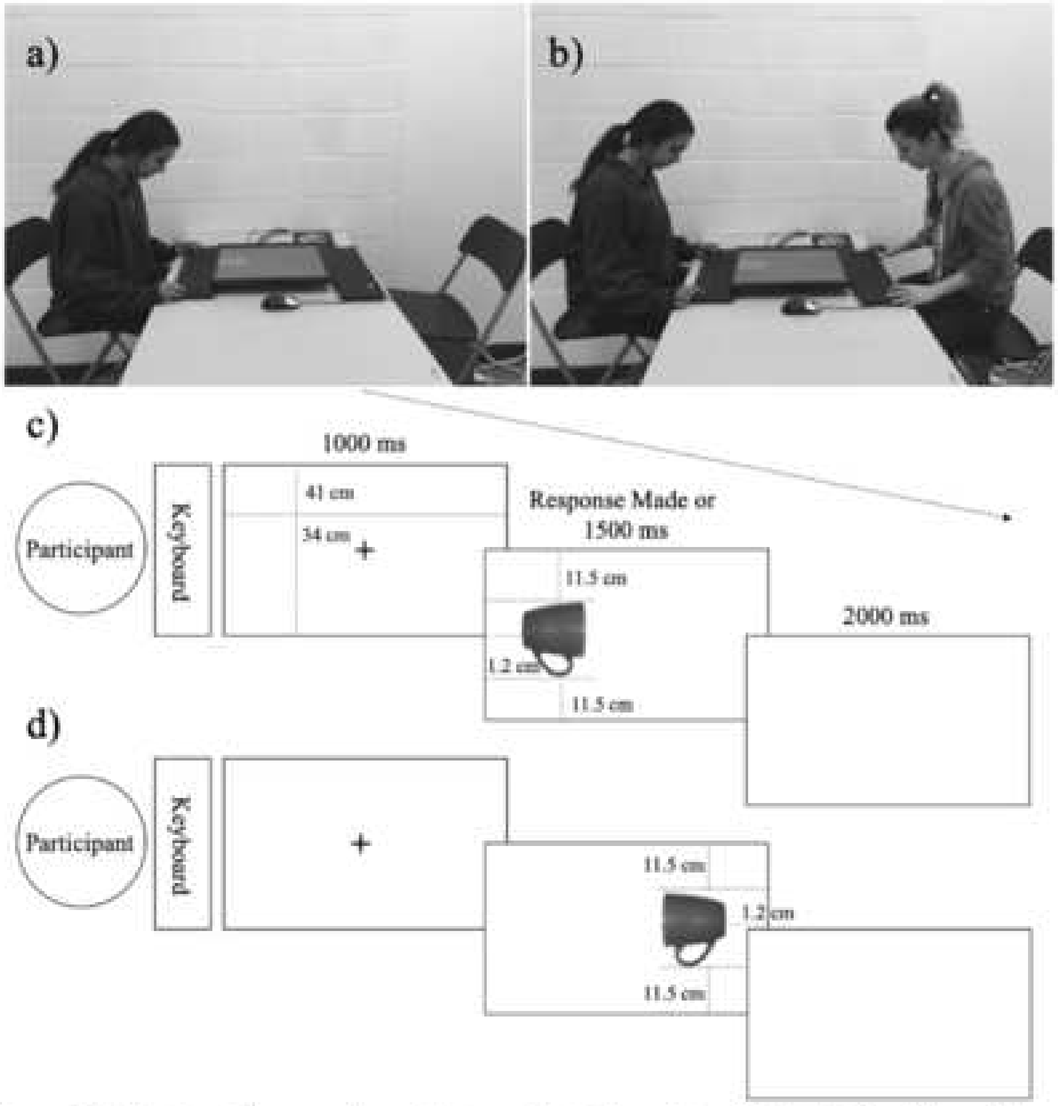

Figure 1. Depiction of the experimental set-up in the Alone (a) and Joint (b) Conditions. Figure 1(c) is a depiction of an incompatible trial with an upright mug at the 'near' location (assuming the participant is situated at the circle labelled, 'participant'). Figure 1(d) shows a depiction of a compatible trial with an inverted mug at the 'far' location. Dashed lines and numbers did not appear in the actual figure used in the study. Images are not to scale.

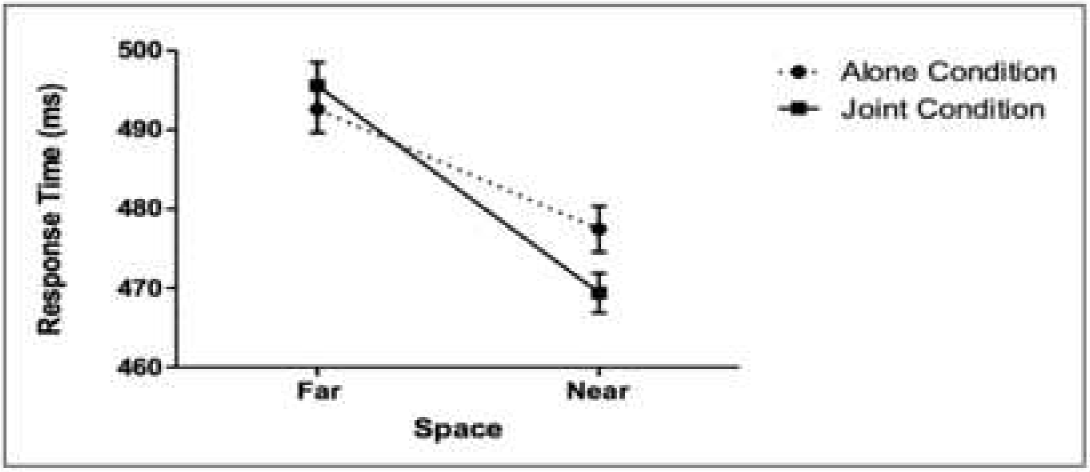

Figure 2. Mean response time (ms) as a function of Space and Social Context. Error bars represent standard error of the mean. The description of space pertains to whether the stimuli were located near or far from the participant.

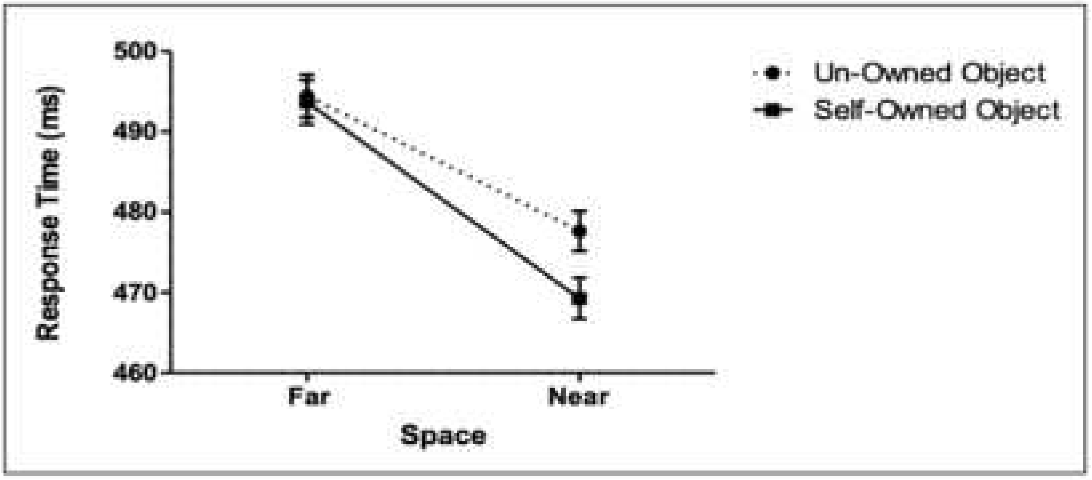

Figure 3. Mean response time (ms) as a function of Space and Ownership. Error bars represent standard error of the mean.